OBSTETRIC APPLICATION OF ULTRASOUND*

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ULTRASOUND continues to strengthen its role as a vital tool in obsetetrics where this technical examination to date, and by all studies, is safe to developing tissues. As technology advances, examination of the developing embryo intensifies. Ultrasound allows physicians to delve into human embryology and fetology and, combined with biochemical, biomechanical, and other clinical information, to promote the neonate's health.

This discussion reviews a number of critical aspects of care for pregnant patients. These include confirmation of an established normal pregnancy and subsequent normal development of the embryo and fetus. A number of indices of development will be discussed as well as methods by which they can be incorporated into optimum obstetrical care. Fetal structural and functional abnormalities as well as placental, uterine, and adnexal abnormalities will be reviewed with the aim of early and accurate diagnosis.

THE DIAGNOSIS OF PREGNANCY

A most common reason for ultrasound examination is diagnosis of an intrauterine pregnancy. With the advent of sensitive pregnancy tests, early diagnosis is important in a variety of circumstances—abnormal uterine bleeding, prior pelvic infections, prior tubal surgery. The early gestational sac is characterized by its location high in the corpus of the uterus, its anechoic center, and its dense peripheral echoes of decidual reaction. These characteristics are best seen at six weeks of amenorrhea but may be suggestive at five weeks. Absence of these findings would suggest search for a tubal pregnancy, the most common extrauterine pregnancy. This can be a challenging study ultrasonographically, as seen in Figure 1. Initial examination gave the appearance of an intrauterine pregnancy. Worsening symptoms prompted reexamination which yielded a somewhat irregular saclike structure and an

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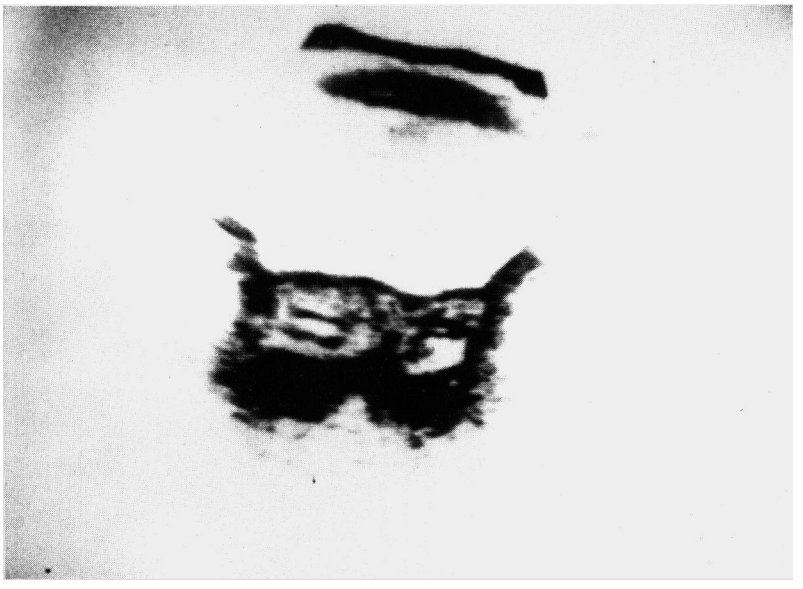

Fig. 1. Transverse scan of left ectopic pregnancy, demonstrating intrauterine reaction

enlarging adnexal mass. Review of our statistics show an 83% correct diagnosis for ectopic pregnancy.[1]

The history of infertility and the use of fertility drugs, particularly human menopausal gonadotropins (Pergonal), warrants early ultrasound examination for the number of gestational sacs and to evaluate the degree of ovarian stimulation. It may even be necessary to repeat the scan after an interval of time for the correct diagnosis of the number of gestational sacs.

Fetal Growth Determinations

A number of indices have been studied over the years for accurate and reliable estimation of fetal age. In general, the patient's history and medical status, combined with biparietal diameter, abdominal circumference, and total intrauterine volume are evaluated. The number of examinations required may vary, again, depending on history and any medical changes that may occur during the pregnancy. The first trimester crown-rump measurement may be all that is necessary to determine the expected date of confinement in an otherwise normal pregnancy. Midpregnancy scans are valuable in scheduling repeat cesarean section and perhaps avoiding amniocentesis later in the pregnancy if there is agreement with the menstrual history.

Measurement of the biparietal diameter and the abdominal circumference gives vital information about the age and health of the pregnancy. Alone, the biparietal diameter will date the pregnancy and, in many cases, the last period is found unreliable. But discrepancy between the biparietal diameter and abdominal circumference may lead to earlier diagnosis of growth retardation. Biparietal diameter curves of normal and growth retarded fetuses have been constructed. Two types of retardation can be demonstrated—the low profile of symmetrical growth retardation where there is slow but continuous growth of the biparietal diameter and late flattening or asymmetrical growth retardation.[2] The latter is more ominous, and placental insufficiency may be documented by positive oxytocin challenge tests and low estriol determinations. The former pattern of growth is not placenta related but genetic, infectious or perhaps congenital, and has a more favorable outcome. The use of the head/abdomen ratio can segregate the two groups at risk and is more diagnostic of the group likely to have placental insufficiency.[3]

Intrauterine volume measurements can also predict a fetus at risk because all tissues—fetus, placenta, and amniotic fluid—are affected by a similar ongoing process. Given a gestational age, deviation from the normal curve by 1.5 standard deviations will more than likely result in a growth-affected fetus.[4]

Because the late flattening type of retardation occurs late in the third trimester, sequential scanning every 1 or 2 weeks is necessary, particularly in mothers with hypertensive vascular disease. Delivery can then be accomplished when other indices show fetal jeopardy or when pulmonary maturity has been reached.

Detection of Abnormalities

An early gestational sac may contain fetal echoes. If the examination is performed after eight weeks gestation, both an active fetus and fetal cardiac activity can be seen using the real time modality. These are optimistic findings in a patient who has been bleeding since most of these pregnancies will continue. If no fetal parts are found, follow-up examination in two weeks may confirm a normal pregnancy or lead to the diagnosis of blighted ovum, where a large empty sac is seen. The pregnancy test (to clarify the difference between a blighted ovum and a missed abortion, where the test would be negative) is usually positive in this instance but in the range of 5,000 to 10,000 international units per 24 hours.

A molar pregnancy is occasionally detected at this time as well, but is typically a second trimester finding. Here, the reverse of the blighted ovum is found, and the uterus is filled with snowstormlike echoes, large cystic adnexal masses are large and cystic, and very high gonadotropin levels (in urine or blood).

During the second trimester of a pregnancy with a fetus, more detailed examination can be performed. A scan prior to placement of a cervical suture will determine relative normalcy and viability of the pregnancy. Further genetic investigation at 16 or 17 weeks of gestation is carried out by amniocentesis under ultrasound guidance. Two-dimensional scans to place the needle are obtained. This often means traversing the placenta, usually without any subsequent difficulty. Maternal and fetal amniotic fluid alpha-fetoprotein samples are obtained to assess possible neural tube defects as well as for chromosome analysis. Structural evaluation for neural tube defects is made at the initial scan, first by defining the midline echo of the fetal skull. This echo should be midline and have symmetrical anatomy on either side. The thalami and third ventricle can be identified. A suspicion of hydrocephaly is raised if the biparietal diameter measurement is greater than the menstrual history indicates, or if the midline echo is displaced or if internal structures are lacking. Anencephaly and spinal defects are part of the spectrum. Because neural tube defects can present as different anatomical lesions, open or closed and of variable onset, sequential scanning during pregnancy is suggested for early diagnosis and for reassurance.

The urinary tract can also be investigated in utero. A cystic mass, anterior and caudad, in the fetal abdomen represents the fetal bladder. The bladder's identification is important when Potter's syndrome is being considered. Fetal kidneys can be identified more readily from transverse scanning of the fetus with its back up. Enlarged polycystic or dialated, hydronephrotic kidneys can be identified. Dynamic renal function can also be calculated by timed sequential examination and bladder volume calculations.

Gastrointestinal abnormalities are detectable when outflow obstruction, caused by malformation or by displacement, is present. Cystic masses may be seen in the lower abdomen in the case of imperforate anus, the midabdomen at the umbilicus in the case of omphalocele or near the stomach area in the characteristic "double bubble" sign of duodenal stenosis (Figure 2). Large abdominal wall defects may allow a large gastroschisis or herniation through a diaphragmatic defect. Realtime examination allows dynamic examination of motion of the diaphragm and intestinal structures. Coincident with such a finding would be an evaluation of fetal lung tissue which, because

Fig. 2. Longitudinal scan of fetus demonstrating the anechoic areas of the fetal heart on the right, the bladder on the left, and the "double bubble" of gastric obstruction in duodenal stenosis

of a mass occupying effect, could be compressed and thus prevent full pulmonary maturation.

Gross examination of the heart is possible, particularly using the realtime modality. Overall size, number of chambers, rate, and rhythm can be evaluated. M mode echocardiography is possible but limited by fetal position. Thus, obstructive of hypoplastic lesions and electrical conduction lesions can be evaluated. Fetuses of mothers with lupus erythematosus are susceptible to the effects of the maternal disease and one of these effects is interruption of the conduction system of the interventricular septum with subsequent heart block.

Skeletal dysplasias can be recognized by the length and shape of the bones of the extremities and the limb defect can be located. The achondroplasias and the types of osteogenesis imperfecta can be studied. Bowing, fractures of the long bones, and spinal displacement can be assessed. The fetal skull in lethal osteogenesis imperfecta is poorly mineralized, irregular in outline, and, by realtime examination, deformation of the skull may be demonstrated.

Hydrops fetalis, secondary to Rh isoimmunization, is the most common immunologic disease seen in pregnancy. The hydramnios and fetal edema that occur markedly enhances fetal and placental structural details. Ultra-

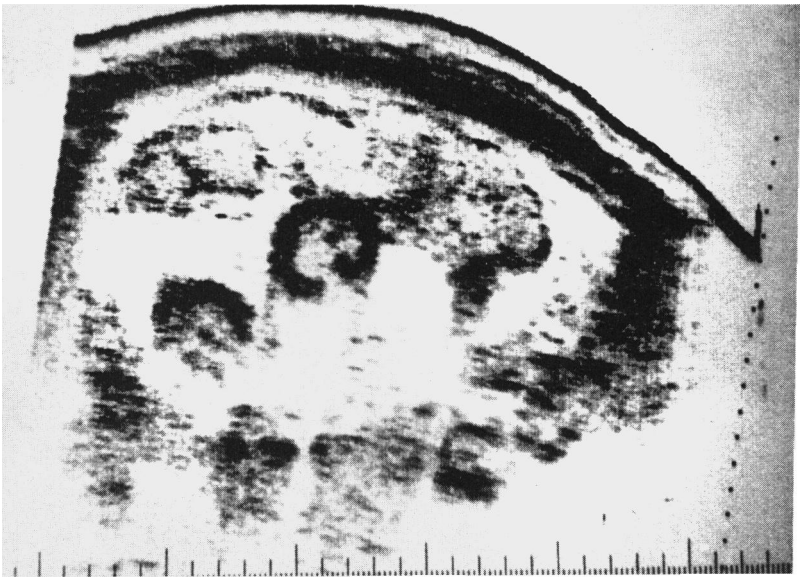

Fig. 3. Longitudinal scan of the Grade III placenta

sound guided amniocentesis is critical in the care of these patients, both for amniotic fluid bilirubin determinations and to instill radiopaque material necessary for intrauterine transfusions.

Placental morphology is also accentuated in hydrops, and hypertrophy may be an early sign of an affected fetus. Location, texture, and configuration are also evaluated during scanning. Placenta previa, complete or partial, is frequently found in second trimester studies. The placentae previae that are most significant for the third trimester are the central type, where the bulk of the placenta occupies the area of the lower uterine segment, covering the cervix and extending to all sides. Active bleeding of a placenta previa may produce the additional finding of placental separation with blood clots seen behind the placenta. Chronic separation shows more subtle changes in the echogenicity of the placenta and may be difficult to delineate.

Another placental finding is the presence of calcification. A Grade III placenta (Figure 3), with peripheral dense echoes secondary to calcification and the rounded shape of cctyledons, is found after 36 weeks. If pulmonary maturity studies are not technically possible, this finding is reassuring because no respiratory distress has been associated with this preoperative finding.[5]

Fig. 4. Transverse scan of a molar pregnancy and the theca lutein cyst on the left

Uterine abnormalities may influence the outcome of pregnancy, i.e., preventing conception, or promoting early abortion or premature delivery. A uterine myoma tends to enlarge under estrogen stimulation and, with increased vascularity, may undergo degeneration. A submucous or intramural myoma is more likely to cause these problems. A subserous myoma is more likely, by its size and location, to obstruct normal vaginal delivery. Ultrasound, then, besides confirming the length of gestation and viability of the pregnancy, will determine the location, number, and echo characteristics of a myoma that would suggest degeneration.

The echogenicity of myomas can vary from sonolucent to sonocomplex with evidence of calcification. Such variety can make the distinction from an adnexal mass quite difficult. Cystic adnexal masses are not uncommon in normal intrauterine pregnancy and are usually quite well defined. Corpus luteum cysts usually do not persist and do not reach significant size. Theca lutein cysts can reach enormous size, by multicystic, and are associated with molar pregnancy (Figure 4). Similar findings can be seen with the use of gonadotropin induction of pregnancy, and ascites is also seen in this hyperstimulation state. A dermoid cyst can also present as a varied sonocomplex mass but sometimes its position differentiates it from a hemorrhagic cyst.

SUMMARY

The versatility of ultrasound has contributed immensely to the care of antepartum patients and is broadening the scope of perinatal medicine. This discussion has emphasized the ultrasonic care of an established pregnancy and its use in fostering the normalcy of the developing fetus by endocrine, genetic, and biochemical collaboration. Monitoring of fetal growth continues to be of utmost importance for the birth of a mature neonate. A number of measurements, including biparietal diameter, abdominal circumference, and intrauterine volume measurements, aid greatly in achieving this end. The detection of abnormalities that prohibit totally or partially full development of the fetus is expanding as rapidly as technology evolves. Evaluation of the nervous, cardiopulmonary, renal, gastrointestinal, and musculoskeletal systems is part of "routine" obstetrical ultrasound examination. Thus, the information gained from such routine examinations has had a revolutionary impact on the practice of modern obstetrics.

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